WEBSIM PROPOSAL (FY00)

PROJECT TITLE: Web Based Simulation for Combat Modeling Instruction and Distance Learning (WebSim)

POINT OF CONTACT: US Army TRADOC Analysis Center
MAJ Leroy A. Jackson
(831) 656-4061 (DSN 878)
PO Box 8692, Monterey, CA 93943-0692
Fax: (831) 656-3084 jacksonl@trac.nps.navy.mil

EXECUTIVE SUMMARY: This proposal seeks $175K to fund phase I of the WebSim project. That project will prototype and develop simulation components for combat modeling instruction and distance learning. In the first phase, the research team will develop and integrate software components into the NPS Joint Combat Modeling course. The first phase culminates with the completion of the resident course. In the second phase, the course content from phase I will be packaged for distance learning via the internet.

This project will produce simulation components to support combat modeling instruction at the United States Military Academy (USMA) Systems Engineering Department, the Naval Postgraduate School (NPS) Operations Analysis (OA) Department, and the Air Force Institute of Technology (AFIT) Department of Operational Sciences (OS).

The project will use several software components prototyped in Java at the NPS including a discrete event simulation framework, a modular terrain component, an interactive, geo-referenced map and overlay display component, and a framework for modeling and solving graph and network problems. These and other components developed during this project will be provided to the COMBAT XXI development team.

FUNDING PROFILE:

$K	Prior Funding & Source	FY 00 OMA	FY 01 OMA	Project Total
TRAC PHASE I		$175K	$100K	$275K
SimUtilities AMIP		$60K		$60K
ModTerrain AMIP	$75K			$75K
NPS LCC SOCOM	$50K			$50K
NPS LCC IJWA	$50K			$50K
NPS LCC AF S&A	$260K			$260K
Total	$435K	$235K	$100K	$770K

Note: There is no charge for several man-years of work by TRAC-Monterey military analysts and Naval Postgraduate School and Air Force Institute of Technology students. AMIP funding for the Simulation Utilities (SimUtilities) project has not been approved. The Modular Terrain Component for Entity Level Computer Generated Forces (ModTerrain) project was funded by the Army Model Improvement Program in FY99. The Loosely Coupled Components research group (LCC) at the Naval Post Graduate School was funded by the Air Force Department of Studies and Analyses, the Special Operations Command and the Institute for Joint Warfare Analysis in FY98 and FY99. This project will continue to leverage their FY00 and FY01 funding and research.

Background and Technical Description of the Problem.

Background. The United States Military Academy (USMA) Systems Engineering Department, the Naval Postgraduate School (NPS) Operations Analysis (OA) Department, and the Air Force Institute of Technology (AFIT) Department of Operational Sciences (OS) teach combat modeling and related subjects. These academic institutions and several military schools such as the command and staff colleges and the war colleges support instruction with wargaming and simulation. These institutions use a variety of aging legacy models.

The TRADOC Analysis Center (TRAC) at White Sands, New Mexico (TRAC-WSMR) is developing COMBAT XXI to replace CASTFOREM, an analytical constructive simulation of combat at the brigade and battalion level. The development team has selected Java and is evaluating and using components developed by NPS. The NPS Loosely Coupled Components (LCC) working group has prototyped several software components in Java that support simulation. Four prominent prototypes are described below.

(1) **Simkit** is a discrete event simulation framework based on the event diagram paradigm. The NPS OA faculty and students and the AFIT OS faculty and students use Simkit extensively for instruction and thesis research. The COMBAT XXI development team is using Simkit in their prototype development and is evaluating Simkit for production use in COMBAT XXI.

(2) **ModTerrain** is a modular terrain component designed to allow simulation developers to substitute one terrain representation for another within the same simulation. It includes routines to access terrain elevation and feature data and high level terrain related algorithms such as line of sight. An NPS student has coded a reference implementation of ModTerrain in Java using Janus terrain and algorithms. ModTerrain will be nominated as an Army standard in Fiscal Year 1999 after extensive experimentation with a prototype reference implementation in C++ using ModSAF Compact Terrain database (CTDB). COMBAT XXI will use a Java implementation of ModTerrain.

(3) **Flora** is an interactive, geo-referenced map and overlay display component. It supports standard features such as pan, zoom, fade, and enhance. It displays the cursor elevation and location in lat/long and UTM. Flora uses NIMA provided ADRG and DTED data or any other geo-referenced image such as a satellite map. Flora displays standard military symbols on overlays. The original version of Flora is used by NATO contingency planners. COMBAT XXI is evaluating Flora for their development effort.

(4) **König** is a framework for modeling and solving graph and network problems. It provides dynamic attribute sets that are well suited for entity modeling. König is used at the NPS and at AFIT for thesis research and by the National Security Agency (NSA) for algorithm development.

Technical Description. This research address three closely related problems.

(1) Most current simulations are not well suited for distance learning. Many are only marginally functional for resident learning. They typically require special hardware, and special training to operate.

(2) There are no readily available coded combat modeling examples for student research. This prevents combat modeling students from directly exploring the behavior of algorithms and from experimenting with various implementations.

(3) There is no library of re-usable simulation components. Operations Research students frequently construct simulations with combat models as part of their thesis research. In most cases, the student must create the simulation from scratch. Simulation development efforts such as COMBAT XXI need similar components.

Technical Approach.

Approach. The research team will develop the web-based simulation components in Java. Sun Microsystems describes Java as a "simple, object-oriented, network-savvy, interpreted, robust, secure, architecture neutral, portable, high-performance, multithreaded, dynamic language." Java is a high-level (i.e., third-generation) programming language designed for use in a distributed environment such as the Internet. It is similar to the C++ language, but it is simpler and more fully object-oriented. Java can be used to create complete applications that may run on a single computer or be distributed among servers and clients in a network. It can also be used to build small application modules or applets for use as part of a Web page.

The first phase culminates with the completion of the Joint Combat Modeling resident course. Architecture development and basic component implementation is the critical activity in this phase. In the second phase, the course content from phase I will be packaged for distance learning via the internet.

Phase I. (12 months)

(1) The first step of Phase I is to design the simulation architecture while implementing critical simulation components and designing the resident and non-resident combat modeling course content.

(2) The second step of Phase I is to integrate components into the architecture while developing the residence course content.

(3) The final step of Phase I is to integrate simulation components and resident course content while validating the resident course.

Phase II. (6 months)

(1) The first step of Phase II is to develop the non-resident course using the resident course content.

(2) The second step of Phase II is to integrate the simulation components into the non-resident course content.

(3) The final step of Phase II is to prototype and validate the distance learning combat modeling course.

Feasibility. The technical feasibility of this approach is demonstrated by the numerous simulations developed by NPS students for thesis research. TRAC-Monterey has extensive experience in advanced distributed simulations and simulation architectures.

Impact of Project on Army After Next Technology Voids.

Military planning systems must evolve to meet the challenges of conducting military operations in the information age. The Department of Defense Joint Vision 2010 suggests the next generation of military planning systems will accelerate the tempo of analysis, operate over computer networks and on different computer platforms, and incorporate simulation technology for mission planning. Even the best-integrated planning tools today do not provide adequate interoperability, platform independence, or extensibility. Future planning systems must address new situations and needs of decision-makers that designers have not yet anticipated. These planning systems will feature an open architecture enabling new functions and capabilities to be added without disruption.

The University After Next (UAN) supports the Army After Next (AAN) by developing leaders and by providing online knowledge distilled within interactive libraries and simulation. One UAN critical issue is how to provide "subscription to a wide array of usable training products ranging from coursework to tailored simulations". Web based simulation fills this void.

Products.

- Java Software Components. This research will produce several re-usable software components implemented in Java.
- Joint Combat Modeling Course. This research will integrate simulation components into a combat modeling course and produce a set of course content to support resident and distance learning.
- Technical Report. This research will produce a comprehensive technical report that documents the software components. It will also produce various thesis products by masters students and various papers by members of the research team.

Milestones.

Phase I. (First Year)

Step 1. Architecture Defined and Course Designed (Start + 6 months)
Step 2. Integration Complete & Content Developed (Start + 9 months)
Step 3. Resident Course Validated (Start + 12 months)

Phase II. (Second Year)

Step 1. Non-Resident Course Developed (Start + 13 months)
Step 2. Component Integration Complete (Start + 15 months)
Step 3. Non-Resident Course Validated (Start + 18 months)

Risk/Benefit Analysis.

Risk. The technical risk is minimal. The challenge is to design a simple architecture that can accommodate new components and then integrate the various current prototypes. TRAC-Monterey and NPS have extensive experience in this area. The ASTARS repository of Army Modeling and Simulation standards also mitigates risk substantially. The project will seek to leverage current and emerging Army standards extensively. The joint combat modeling course is well established at NPS and the AFIT course shares the same set of instructor notes.

The Java programming language has matured rapidly over the past four years and there are numerous API's associated with the language. The current policy states that, “Programming language selections should be made in the context of the system and software engineering factors that influence overall life-cycle costs, risks, and potential for interoperability.” The Joint Technical Architecture (JTA) Information Processing Standards say that, "The Java Virtual Machine (JVM) and supporting libraries are an emerging standard. The JVM may be used to support applications executed through a web browser or to support development of portable applications."

Benefits. The benefits of this project are significant. This work supports two distinct objectives. First, it provides a vehicle for teaching and research with combat modeling by operations research analysts and simulation specialists. Second, this work directly benefits the COMBAT XXI simulation development effort. Most of these benefits are realized in the first year of project. A set of platform independent combat models will serve many teaching and research requirements. The simulation components can still be delivered to students via the world wide web and run as stand alone models to support distance learning. The components will also still facilitate combat modeling instruction and research.

Executability.

Phase I Funding Requirements:

$45K	Dr. Lucas	NPS OR/MOVES Professor (combat modeling)
$40K	Dr. Buss	NPS OR/MOVES Professor (simulation)
$35K	Dr. Shing	NPS CS Professor (computer architectures)
$40K	Contractor	TBD (component development)
$15K	Other	Travel, hardware, software support, overhead, etc.

Total: $175K

Phase II Funding Requirements:

$45K	Dr. Lucas	NPS OR/MOVES Professor (combat modeling)
$40K	Contractor	TBD (multi-media technical publication on the web)
$15K	Other	Travel, hardware, software support, overhead, etc.

Total: $100K

Phase I. Approximately 30% of the work will be accomplished by TRAC-Monterey; however, most the money will be used to hire contractor support and obtain support from NPS professors. About 40% of the work will be accomplished by professors and students at NPS and AFIT. Professors Thomas Lucas, Arnold Buss (OA) and Man-tak Shing (CS) will be the principle investigators at NPS. There is no charge for work performed by the students. The remaining 30% of the work will be accomplished by a contractor through the NPS support contract which is readily available to TRAC-Monterey.

Phase II. This is a rough estimate for this phase. Approximately 20% of the work will be accomplished by TRAC-Monterey. About 30% of the work will be accomplished by professors. Dr. Tom Lucas will be the principle investigator at NPS. TRAC-Monterey will contract the remaining 50% of the work to a professional multi-media design company for technical publication on the internet as an interactive course. The TRAC-Monterey network can host and serve the course until a revenue stream is established for support.